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AUTHOR Park, Rolla Edward
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A statistical analysis of new data suggests that television broadcasting will continue to prosper, despite increasing competition from cable television carrying distant signals. Data on cable and non-cable audiences in 121 counties with well defined signal choice support generalized least squares estimates of two models: total audience and audience shares. The models are used to simulate the effect of cable on the audience of local stations in a wide variety of situations. In markets with three network stations, for example, the simulations show two percent audience loss due to cable operating under current regulations, seven percent loss in the near term under relaxed regulations allowing carriage of more distant signals, and up to 20 percent loss in the future if cable penetration increases substantially. Losses are greater in smaller markets. Comparison shows these results to be broadly consistent with previous studies. It is a contribution to the Federal Communications Commission's "Inquiry into the Economic Relationship between Television Broadcasting and Cable Television." A list of references is provided, as well as a description of the data and equations estimated for time periods other than prime time. (Author/JEG)

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PREPARED FOR THE FEDERAL COMMUNICATIONS COMMISSION

ROLLA EDWARD PARK

R-2403-FCC

APRIL 1979

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PREFACE

The Federal Communications Commission's current *Inquiry into the Economic Relationship between Television Broadcasting and Cable Television* seeks information to guide the Commission's continuing re-evaluation of its cable television regulations. One of the central questions in the *Inquiry* is: How much audience is diverted from local TV stations by cable systems carrying distant signals? This report provides some answers, based on a statistical analysis of new audience data assembled by the FCC's Cable Bureau. The data are reproduced in full in a companion volume, *Audience Diversion Due to Cable Television: Supporting Data*, R-2403/1-FCC.

The results will be of interest to anyone concerned with the regulation of cable television, including people in government and in the broadcasting and cable industries. This study builds on Rand's extensive previous work on the federal regulation of cable television.

ABSTRACT

A statistical analysis of new data suggests that television broadcasting will continue to prosper, despite increasing competition from cable TV carrying distant signals. Data on cable and non-cable audience in 121 counties with well-defined signal choice support generalized least squares estimates of two models: total audience and audience shares. The models are used to simulate the effect of cable on the audience of local stations in a wide variety of situations. In markets with three network stations, for example, the simulations show 2 percent audience loss due to cable operating under current regulations, 7 percent loss in the near term under relaxed regulations allowing carriage of more distant signals, and up to 20 percent loss in the future if cable penetration increases substantially. Losses are greater in smaller markets. Comparison shows these results to be broadly consistent with previous studies. This is a contribution to the Federal Communications Commission's *Inquiry into the Economic Relationship between Television Broadcasting and Cable Television.*

ACKNOWLEDGMENTS

My Rand colleague Willard Manning contributed substantially to the technical quality of this report by suggesting the use of non-linear regression to obtain unbiased estimates of the audience share model. He also made other useful comments on an earlier draft, as did Robert Crandall, The Brookings Institution; Bridger Mitchell, The Rand Corporation and the International Institute of Management; Bruce Owen, Duke University; and Steven Zecola, the Federal Communications Commission.

David Nicholl at the FCC provided consistently cheerful help on administrative matters. I am also grateful to other FCC staff members for help in assembling and understanding a useful data base, and to members of Ruth Mitchell's effective writing workshop at Rand for suggestions that much improved the organization of the report.

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I. INTRODUCTION AND SUMMARY

What effect does cable television carrying distant signals have on the size of the audience of local television stations?

Some answers, based on my statistical analysis of new audience data, are shown in Table 1. The first line for each representative market simulates the effect of distant signals allowed by present regulations. The effect ranges from a 3 percent increase in audience for UHF independent stations in the largest markets to a 10 percent decrease in audience for VHF network affiliates in the smallest markets. The second and third lines for each representative market simulate the effect of relaxed regulations that would allow cable systems to carry more distant signals than they now may. The effect of the additional distant signals is to reduce audience by a further 11 percent in the worst case shown.

Although the numbers vary depending on market and cable system characteristics, none seems large enough to cause alarm. The evidence in this report leads me to believe that TV broadcasting will continue to prosper, despite increasing competition from cable.

This introductory section provides a concise overview of my methods and results. Additional simulations covering a wide variety of present and future market situations are in Section III, which also includes comparisons to previous studies. Section II, which documents the methods used in full detail, is addressed primarily to technical readers.

BACKGROUND

In 1972, the Federal Communications Commission adopted rules for cable television that, with minor modifications, remain in force today. The rules are a cautious attempt "to get cable moving so that the public may receive its benefits without, at the same time, jeopardizing the basic structure of over-the-air television."[1] The dilemma arises because of cable's carriage of television signals from distant markets, in

[1] FCC (1971, p. 5).

Table 1

NEAR-TERM EFFECT OF CABLE ON LOCAL STATION AUDIENCE IN REPRESENTATIVE MARKETS UNDER PRESENT AND POTENTIAL RELAXED CABLE REGULATION: SIMULATION RESULTS

Local Stations				Distant Stations on Cable		Cable Penetration[a]	Percentage Change in Local Station Audience[b] Due to Cable				
Network		Independent					Network		Independent		
VHF	UHF	VHF	UHF	Net.	Ind.		VHF	UHF	VHF	UHF	Total
3	0	1	1	0	2	16	-2		-2	+3	-2
(Representative of top-50 markets)				0	6	16	-5		-5	-1	-5
				3	6	16	-7		-7	-3	-6
3	0	0	0	0	2	17	-2				-2
(Representative of second-50 markets)				0	5	17	-6				-6
				3	5	17	-7				-7
1	1	0	0	1	1	32	-10	-2			-8
(Representative of below-100 markets)				1	4	32	-17	-12			-15
				4	4	32	-21	-16			-19

SOURCE: Table 7.

[a]Average present penetration in markets of each type. Data supplied by FCC Cable Bureau.

[b]Average audience over the full broadcast day. The base assumes that 100 percent of the audience watches local stations in the absence of cable (no overlapping signals from adjacent markets).

addition to those of local stations. On one hand, the additional diversity offered by cable is valued by consumers;[1] some 13 million households in this country now pay a monthly fee for cable service.[2] On the other hand, distant signals divert some audience from local stations, and hence decrease their advertising revenues. If the diversion were sufficiently large, it might cause the stations to cut back on the quality of their programming, or even, conceivably, force them off the air. In promulgating its cable television rules, the FCC was attempting to balance the potential gains to cable subscribers against the potential losses to those who do not subscribe.

The Commission adopted its rules in the face of considerable uncertainty as to what the effect of cable on broadcasting actually would be. It had before it studies by broadcast and cable interests and disinterested parties that seemed to show the possibility of a wide range of effects--all the way from severe harm to, in certain circumstances, substantial help. One reason that the studies disagreed is that there were very few data to go on. Although two national rating services collect detailed data on television audiences, they did not at that time keep separate track of cable and non-cable viewing; there was almost no direct evidence about how cable households divide their viewing time between local and distant signals.

In the face of this uncertainty, the Commission chose to act cautiously and incrementally. The 1972 rules allow cable systems within 35 miles of a city with a television station to carry a very limited number of distant signals[3]--small enough to preclude any substantial risk of serious harm to broadcasting, yet large enough, it was hoped, to encourage the expansion of cable into new areas, particularly large markets with good off-the-air television service.

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[1] One study puts the amount that consumers would be willing to pay for additional signals very high, for example, 1 percent of household income for a third network station. See Noll, Peck, and McGowan (1973, p. 288).

[2] *Television Digest*, March 27, 1978.

[3] Systems located outside any 35-mile zone may carry as many signals as they choose to.

The Commission intended to watch what would happen under the 1972 rules and to take further action, if warranted, as additional information became available. It took a major step in this monitoring process when it issued its 1977 *Notice of Inquiry into the Economic Relationship between Television Broadcasting and Cable Television* (hereafter *Economic Inquiry*). The present report attempts to provide answers to some of the questions raised by that work.

NEW AUDIENCE DATA USED IN THIS REPORT

The new data on cable and off-the-air television audiences in individual counties used in this report are much "cleaner" than the data used in earlier studies,[1] in the following sense. Earlier studies used market-level audience data. These data lumped together cable and non-cable audience, and aggregated over a much larger geographical area than a single county. This raises a difficult problem for analyses that attempt to relate size of audience to the choice of signals available, because that choice varies widely within any given television market. There are typically many different cable systems in a market, each offering its own package of television signals. Off-the-air service can differ greatly from cable service, and can in addition vary widely from place to place within the market; for example, overlapping signals from adjacent markets may be available in some places but not in others.

These problems are minimized in my data base; I can relate audience behavior to a well-defined set of signal choices. Only counties with a single cable system in operation are included in the data base; thus all cable households in one of my counties can watch exactly the same signals. Although the same is not perfectly true for non-cable households, it is certainly a much better approximation for county data than it is for market data, since the county is a much smaller geographical area.

---

[1] I am thinking particularly of my own contribution to the FCC proceeding that led to the 1972 rules (Park, 1970) and the well-known book on television economics by Noll, Peck, and McGowan (1973). For a summary of early results, see Besen et al. (1976).

METHOD USED AND SOME INTERMEDIATE RESULTS

To answer the overall question--what effect does cable have on local station audience size?--I broke the question down into two components:

1. How does cable affect *total* audience, that is, the number of households watching either local or distant signals?
2. How does cable affect audience *shares*, that is, the division of audience among local and distant signals?

I fitted separate models of total audience and audience shares to the new data, using the statistical technique known as generalized least squares regression (GLS). I then used the fitted models to make projections of the effect of cable on local station audience size in a wide variety of situations, such as those reported in Table 1.

GLS is a better method for estimating these models than is ordinary least squares (OLS), which was used in some earlier studies. GLS takes account of relationships in the data that are ignored by OLS, and hence produces more precise estimates.

Although the projections (like those in Table 1) are the central results of this report, there are intermediate results from the two models that are also worth noting.

Total Audience Model

From the very beginning of attempts to analyze the effects of cable on broadcast stations, it has been observed that cable households tend to watch more TV than do non-cable households.[1] The question has always been whether or not cable should get the credit for this increased viewing. That is, is there something about cable, such as increased signal choice or better reception, that leads people to increase their viewing after they subscribe? Or are cable subscribers just more avid viewers who would have watched more TV than other people even if they had not subscribed to cable? If the former is true, the effect of cable on the audience of local stations is smaller, because the increased

[1] See, for example, FCC (1970, pp. 11-15), and Park (1970, pp. 21-25).

viewing due to cable is a partial offset to the audience diversion to distant signals. If the latter is true, there is no offset; distant signal audience is all removed from local stations.

My estimates provide weak, but not conclusive, evidence that cable leads to increased viewing because of better reception. However, the size of the effect is not large. Whether or not cable gets the credit for higher viewing generally makes a difference of only two or three percentage points in my projections.

Audience Share Model

For my audience share model, I assume that television audiences tend to divide their viewing among stations they can receive in proportion to numbers that I call "attractiveness indices." The attractiveness index for a station depends only on what kind of a station it is--network affiliate or independent, VHF or UHF, local or distant.

The estimated attractiveness indices show:

- Local stations handicapped by lack of network affiliation or by UHF transmission have lower indices than do network VHF stations.
- UHF stations have their indices increased by 40 to 50 percent when they are carried on the cable, presumably because of improved reception.
- Distant network stations carried on the cable have indices that are much smaller than corresponding local stations. This is probably because many of these stations must be blacked out by the cable operator much of the time to provide nonduplication protection to local network affiliates, pursuant to FCC regulations.
- Surprisingly, the index for distant VHF independent stations is only about half that of local VHF independents. This may indicate that established viewing patterns tend to persist even when signal choice is increased.

THE AUDIENCE DIVERSION PROJECTIONS

Table 1 shows some of the most important of the many audience diversion projections I made for this report. These are near-term projections, in that they assume cable penetration is equal to current levels, without allowance for future growth. They show the effect of cable in three hypothetical markets, selected to represent top-50, second-50, and below-100 market situations, subject to three levels of cable regulation:

1. Existing regulations.
2. Regulations relaxed to allow carriage of additional distant independent stations.
3. Regulations further relaxed to allow carriage of additional distant network stations as well (but with nonduplication protection still provided for local network stations).

In the larger (top-100) markets, projected audience diversion is minimal; it does not exceed 7 percent even with the most relaxed regulations. In smaller (below-100) markets, diversion under present regulations is estimated to be 8 percent, and is projected to double or slightly more if the regulations were relaxed. In all cases, UHF stations are not hurt as much by cable as are VHF stations; in some instances, they may actually be helped. Table 7 in Section III includes projections for other representative market situations, with results that are much the same as those in Table 1.

I also made long-term projections, assuming cable penetration in the entire market reaches equilibrium levels predicted by my early work on cable demand (1971). These assumed penetration levels are generally much larger than the present values used in Table 1--two or three times as large in most cases. Obviously, it will take a long time for these higher penetration levels to be achieved. Indeed they may never be, because they assume, unrealistically, that it is economically feasible to wire the whole market. The assumed penetration is higher in smaller markets, and higher the more distant signals the cable carries.

Long-term projected diversion patterns are similar to the short-term diversion in Table 1, but the magnitudes are larger. Projected

diversion ranges up to 20 percent in markets with three network stations under the most relaxed cable regulations, and much higher than that in markets with only one or two network stations.

COMPARISON WITH OTHER STUDIES

I also made projections that are comparable to those in other studies, and found that all of the studies are broadly consistent. The five other studies are my own early report on cable and broadcasting (1970), similar estimates in Noll, Peck, and McGowan (1973), and studies filed in the FCC's current *Economic Inquiry* by the National Association of Broadcasters, the National Cable Television Association, and the Motion Picture Association of America (all 1978).

QUALIFICATIONS

The simplifying assumptions embodied in my model necessarily distort reality. Here are the most important ways in which they can affect my projections.

1. My projections assume that everyone would watch local stations if there were no cable. This is a fairly good approximation in most large markets, but not in many smaller markets where stations from adjacent markets attract substantial audiences off the air. Indeed, the NCTA study shows that audience diversion off the air is almost as large as it is on the cable in many of the markets that it studied. On this ground, my projections will substantially *overstate* the audience loss due to cable in many smaller markets.

2. Many of my projections (although not those in Table 1) are based on assumed levels of cable penetration that are not likely to be reached for many years, if ever. These projections will tend to *overstate* the near-term effect of cable, and many even overstate the ultimate effect.

3. I make no allowance for diversion of cable audiences to new services such as pay-TV. To the extent that new services grow to attract substantial audience shares, my projections will tend to *understate* audience diversion due to cable.

4. The form that I assumed for my audience share equation assures

that the estimated effect of a sixth imported independent station will be a substantial fraction of the estimated effect of the first--nearly half as large in most markets. There is some evidence that, in reality, the effect of additional stations falls off much more rapidly than that.[1] If so, all of my projections will tend to *overstate* the effect of relaxing the regulations governing distant signal carriage.

5. My estimate of the attractiveness index for a distant network station on the cable is an average of results for two kinds of situations: (a) There are three local network stations in the market, so imported network signals are blacked out most of the time to avoid duplicating the local stations' programming. (b) There are only one or two local network stations in the market, so some imported network signals provide the missing network programming. By using the *average* attractiveness index, I will tend to *overstate* the audience diversion due to imported network stations in the former situation, and to *understate* it in the latter situation.

The net effect of these qualifications, in my judgment, is to assure that most of my projections are conservative. Audience diversion due to cable is not likely to exceed the levels projected.

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[1]FCC, "Methodology for Estimating Independent Television Stations' Audience Shares," undated.

II. DATA AND METHODS: TECHNICAL DETAILS

THE DATA

The starting point for my analysis is data on cable and off-the-air television viewing in 166 counties selected by the FCC Cable Bureau staff. Each of the chosen counties has, according to FCC records, only one cable system in operation. These data are much "cleaner" than those used in earlier studies, as discussed above.

The complete data for all 166 counties are reproduced in Park (1979) for three reasons: (1) Other researchers may wish to use them in their own analyses; (2) a look at the data themselves can add a lot of "texture" to the summary statistics in this section; and (3) the data are of some interest in themselves, particularly as an illustration of the wide variety of television configurations to be found in different places in this country.

The data base was reduced from 166 to 121 counties in two stages. First, four counties were dropped because unlisted stations attract a significant share of cable audience. American Research Bureau (ARB) data do not separately identify foreign stations, stations that individually attract very small shares, and possibly others. Such stations taken together attract over 10 percent of either full-day or prime-time audience on the cable systems in counties 111, 120, 138, and 150. I dropped these counties because the set of listed stations does not reasonably approximate the actual signal choice set.

Second, 41 more counties were dropped because they are apparently located near the fringes of their markets. I want to draw inferences about areas that would be affected by a relaxation of the distant signal restrictions. These areas are all within 35 miles of a television city. In such areas, one would ordinarily expect to find the bulk of the off-the-air television audience watching local stations. If the local station share of off-the-air audience is small in some county, that county is probably not representative of the closer-in areas of present interest. I arbitrarily set the cutoff at 70 percent, and exclude 41 counties with local station shares of less than 70 on a full-day basis.

Summary statistics for the 121 counties that remain are shown in Table 2. Table 3 shows summary statistics for 362 local commercial stations in these 121 counties. In Table 3, notice that VHF station shares are generally smaller on the cable than they are off the air, while UHF station shares are generally larger on the cable.

TOTAL AUDIENCE MODEL

As discussed in Section I, there are two competing hypotheses that might explain why cable households generally watch more TV than do non-cable households. One is that cable leads to increased viewing because it provides more signal choice or better reception. The other is that more avid TV viewers, who watch more than others even before they subscribe to cable, are among the first to sign up for cable service.

Here, I attempt (without complete success) to discriminate between the two hypotheses by estimating a model of total audience that accommodates both. I use the county data described in the previous section. There are separate observations on cable and non-cable viewing in each of 121 counties---242 observations in all. The dependent variables are homes using television (HUT) during each of five time periods. The independent variables are chosen to try to discriminate among possible reasons for higher cable viewing.

Increased Viewing Hypothesis

There are at least two aspects of cable that might conceivably lead people to watch more TV after they subscribe than they did before --better reception and wider choice of signals. If it is better reception, we would expect cable viewing to be higher than non-cable viewing regardless of the choice of signals offered. This suggests including a dummy variable equal to one if the observation is on cable viewing, and zero if it is for off-the-air viewing (CABLEDUM).

If it is wider choice of signals, we would expect homes using television to be positively related to the number of stations viewed. Previous studies using county data have found some increase in viewing as the number of network signals increases from one to three, but little

Table 2

COUNTY DATA SUMMARY STATISTICS

Variable	Description	Off the Air		Cable		Total	
		Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
COTVH	TV households in county in 100s	103.7	241.2	34.0	42.8	137.8	278.6
COPEN	Cable penetration among all homes in the county	--	--	--	--	.301	.137
SYSTVH	TV households passed by cable in 100s	45.8	243.7	37.9	49.6	83.6	286.3
SYSPEN	Cable penetration among homes passed by cable	--	--	--	--	.685	.200
INTAB	TV households sampled by ARB	58.8	73.0	28.2	24.4	--	--
LCLSHR	Full-day audience share for all local stations together (percent)	92.0	8.31	76.8	18.1	--	--
INCOME	Median family income in 1969, $1000	--	--	--	--	7.31	1.41
HUTF	Fraction of TV households using TV, full day	.289	.037	.308	.045	--	--
HUTD	Fraction of TV households using TV, daytime	.218	.054	.223	.059	--	--
HUTE	Fraction of TV households using TV, early fringe	.419	.075	.421	.080	--	--
HUTP	Fraction of TV households using TV, prime time	.595	.066	.626	.090	--	--
HUTL	Fraction of TV households using TV, late fringe	.153	.051	.182	.059	--	--
NNVL	Number of local network VHF stations	2.36	.78	2.37	.74	--	--
NNUL	Number of local network UHF stations	.36	.68	.40	.66	--	--
NIVL	Number of local independent VHF stations	.03	.18	.03	.18	--	--
NIUL	Number of local independent UHF stations	.11	.34	.16	.48	--	--
NNVD	Number of distant network VHF stations	1.60	1.66	3.03	1.92	--	--
NNUL	Number of distant network UHF stations	.14	.57	.30	.76	--	--
NIVD	Number of distant independent VHF stations	.05	.22	.40	.66	--	--
NIUD	Number of distant independent UHF stations	.03	.18	.35	.53	--	--
ETZ	Number of counties in eastern time zone					24	
CTZ	Number of counties in central time zone					88	
MTZ	Number of counties in mountain time zone					8	
PTZ	Number of counties in Pacific time zone					1	

NOTE: See Appendix A for detailed description of data items and sources.

Table 3

LOCAL STATION DATA SUMMARY STATISTICS

Mean and (Standard Deviation)

Variable	Description	Off the Air				Cable			
		Network		Independent		Network		Independent	
		VHF	UHF	VHF	UHF	VHF	UHF	VHF	UHF
SHRF	Full-day audience share of viewing hours	.351 (.183)	.144 (.111)	.130 (.070)	.048 (.045)	.248 (.110)	.168 (.086)	.120 (.036)	.069 (.042)
SHRD	Daytime audience share of viewing hours	.359 (.228)	.117 (.123)	.130 (.099)	.051 (.058)	.264 (.157)	.147 (.108)	.118 (.046)	.072 (.068)
SHRE	Early fringe audience share of viewing hours	.351 (.226)	.122 (.130)	.235 (.198)	.082 (.086)	.227 (.145)	.122 (.089)	.213 (.059)	.097 (.068)
SHRP	Prime-time audience share of viewing hours	.346 (.160)	.175 (.115)	.118 (.047)	.025 (.025)	.250 (.099)	.207 (.108)	.103 (.030)	.043 (.027)
SHRL	Late fringe audience share of viewing hours	.356 (.204)	.143 (.138)	.055 (.019)	.033 (.039)	.256 (.169)	.153 (.137)	.085 (.054)	.055 (.059)
NWC	Net weekly circulation as fraction of county TVH	.858 (.200)	.561 (.312)	.663 (.179)	.029 (.026)	.877 (.161)	.787 (.253)	.778 (.130)	.587 (.247)
NSTAL	Number of local stations of each type	2.45 (.78)	.39 (.73)	.05 (.23)	.17 (.41)	2.46 (.73)	.42 (.70)	.05 (.23)	.26 (.62)
NSTAD	Number of distant stations of each type	1.45 (1.53)	.15 (.59)	.04 (.19)	.03 (.17)	2.83 (1.82)	.34 (.78)	.38 (.66)	.35 (.54)
	Number of stations in file	290	49	4	19	290	49	4	19

or no increase for anything beyond full three-network service.[1] Thus, in addition to a variable that counts the number of stations received by cable or non-cable viewers in each county (NSTA), I include a dummy variable for fewer than three network signals (NNET<3). All of the cable systems in my sample carry at least three (good quality) network signals, so NNET<3 equals zero for all of the cable observations. In creating NNET<3 for off-the-air observations, I count only local network stations, because out-of-market stations are apt to suffer from reception problems.

Self-Selection Hypothesis

The competing hypothesis is that heavy TV viewers subscribe to cable service and light viewers do not. Even if cable has no effect on subscribers' viewing habits, cable households would report higher viewing. How should this self-selection effect be incorporated in a model to explain total viewing? The following (over)simplified example suggests an answer.

Say that, in each market, there is a uniform distribution of viewing hours per household over the range 0 to 12 hours per day. That is, as many households watch between 0 and 1 hour per day as watch between 11 and 12 hours per day, and the same for each hourly interval in between.[2] An extreme version of the self-selection hypothesis is that households subscribe to cable service in exact order of hours watched per day. This would result in the relationship between total

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[1] Crandall (1974) and Park, Johnson, and Fishman (1976, Appendix B).

[2] That this is not wildly unrealistic can be seen by comparing the implied average viewing hours for each household quintile with actual values found by a 1969 Nielsen survey as reported in FCC (1970, p. 12):

	Hypothetical	Actual
Lowest quintile	1.2	1.9
Second quintile	3.6	4.3
Third quintile	6.0	6.2
Fourth quintile	8.4	8.2
Highest quintile	10.8	11.6

viewing and cable penetration shown in Figure 1. If only one household subscribes to cable (near-zero penetration), average cable viewing is 12 hours per day. At 100 percent penetration, cable viewing is just market average viewing, 6 hours per day. Similarly, at zero percent penetration, off-the-air viewers comprise the whole market and watch an average of 6 hours per day. As cable penetration approaches 100 percent, the last holdouts are those households that watch almost no television, so off-the-air average viewing drops toward zero.

More realistically, one expects a rough *tendency* toward self-selection, not the extreme version described above. The main features of Figure 1 would still apply in the realistic case. Both cable and off-the-air viewing would be negatively related to cable penetration,

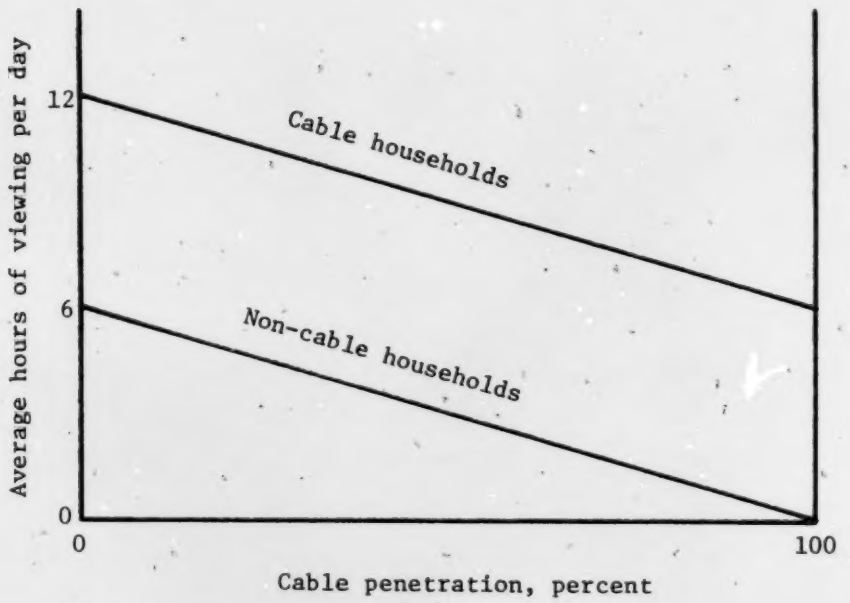

Fig. 1--Simplified example of self-selection hypothesis

and, for any given level of penetration, cable viewing would be higher than off-the-air viewing. The self-selection hypothesis suggests including a dummy variable for cable observations, CABLEDUM, and a penetration variable in the total audience equation.

The definition of an appropriate cable penetration variable is somewhat complicated. The above discussion implicitly assumes that all TV households are passed by cable, so they can subscribe if they want to. In reality, only part of each county is wired. How does this affect the appropriate definition of cable penetration?

Pursuing the extreme example, assume that only a fraction of the county is wired. Then cable average viewing falls from 12 to 6 hours as penetration goes from 0 to 100 percent of *homes passed by the cable*. Thus for the cable observations, the appropriate definition of penetration is subscribers divided by homes passed (SYSPEN, for "system penetration").

As SYSPEN increases from 0 to 100 percent, off-the-air average viewing falls from 6 to 0 hours per week, but only in homes that are passed by the cable. Homes not passed by continue to watch an average of 6 hours per week. Increasing SYSPEN affects off-the-air average viewing for the whole market only in proportion to SYSTVH-0/COTVH-0, where SYSTVH-0 is the number of homes passed by the cable but not subscribing, and COTVH-0 is the total number of non-cable households in the county. While for cable homes the effect of the level of cable penetration on average viewing should be proportional to SYSPEN, for non-cable homes it should be proportional to SYSPEN (SYSTVH-0/COTVH-0). I denote the composite variable (SYSPEN for cable observations, SYSPEN (SYSTVH-0/COTVH-0) for off-the-air observations) by PEN*.

Other Variables

I also include two other variables in an attempt to capture some of the variation in taste for TV. TZONE, a dummy variable equal to one in the central and mountain time zones, is included because the one-hour shift in network schedules in these zones may mesh more or less well with people's schedules and affect the amount of television they choose to watch. INCOME, median family income in 1969, is included as

a proxy measure of socioeconomic status; I expect taste for TV to vary systematically with income and SES generally.

Equation To Be Estimated

Pulling together all of the variables discussed above gives the following equation to be estimated:

$$HUT = \beta_0 + \beta_1 \text{ CABLEDUM} + \beta_2 \text{ NSTA} + \beta_3 \text{ NNET<3} + \beta_4 \text{ PEN*} + \beta_5 \text{ TZONE} + \beta_6 \text{ INCOME} + u \; . \qquad (1)$$

If better reception leads cable subscribers to watch more TV, β_1 should be positive. If more signal choice does, β_2 should be positive and β_3 negative. If the self-selection hypothesis is true, β_1 should be positive and β_4 negative.

Error Structure

In estimating equation (1), I take account of three ways in which the error structure departs from the classical least squares assumption that $V = E(uu') = \sigma^2 I$.

1. Each observation on HUT is based on a number of diaries placed in sample households. The sample size varies widely, from a low of 10 to a high of over 400. I expect the observations to be more reliable when they are based on larger samples, with error variance roughly inversely proportional to sample size.

2. After correction for sample size, I expect off-the-air observations to have higher error variance than cable observations. This is because variation in reception quality will add noise to off-the-air observations while signal quality is uniformly good on the cable.

3. It seems likely that some of the unspecified influences on HUT that are included in the error term affect in the same way both cable and non-cable households in the same county. I therefore expect the cable and off-the-air error terms to be correlated within counties.

These three observations imply the following structure for the error covariance matrix. Order the observations by county, and within

each county put the off-the-air observation first and the cable observation second. Then

$$V = \begin{bmatrix} A_1 & 0 & \cdots & 0 \\ 0 & A_2 & \cdots & 0 \\ \vdots & \vdots & & \vdots \\ 0 & 0 & \cdots & A_n \end{bmatrix},$$

where n is the number of counties in the sample (121) and

$$A_i = \begin{bmatrix} \sigma_o^2/N_{io} & \sigma_o\sigma_c\rho/\sqrt{N_{io}N_{ic}} \\ \sigma_o\sigma_c\rho/\sqrt{N_{io}N_{ic}} & \sigma_c^2/N_{ic} \end{bmatrix}.$$

N_{io} is the number of diaries in non-cable homes in the i^{th} county, N_{ic} is the number of diaries in cable homes, σ_o^2 is the off-the-air error variance, σ_c^2 is the cable error variance, and ρ is the correlation of off-the-air and cable errors within counties. The generalized least squares estimate of the coefficient vector is given by

$$\hat{\beta} = (X'V^{-1}X)^{-1}\,(X'V^{-1}y),$$

where X is the matrix of independent variables (including a vector of ones for the constant term), and y is the vector of dependent variables. In this case we have

$$V^{-1} = \begin{bmatrix} A_1^{-1} & 0 & \cdots & 0 \\ 0 & A_2^{-1} & \cdots & 0 \\ \vdots & \vdots & & \vdots \\ 0 & 0 & \cdots & A_n^{-1} \end{bmatrix},$$

where

$$A_i^{-1} = \frac{1}{1-\rho^2}\begin{bmatrix} N_{io}/\sigma_o^2 & -\rho\sqrt{N_{io}N_{ic}}/\sigma_o\sigma_c \\ -\rho\sqrt{N_{io}N_{ic}}/\sigma_o\sigma_c & N_{ic}/\sigma_c^2 \end{bmatrix}$$

Then $(1-\rho^2)V^{-1}$ can be decomposed as R'R where

$$R = \begin{bmatrix} B_1 & 0 & \cdots & 0 \\ 0 & B_2 & \cdots & 0 \\ \vdots & \vdots & & \vdots \\ 0 & 0 & \cdots & B_n \end{bmatrix}$$

and

$$B_i = \begin{bmatrix} \sqrt{1-\rho^2} & \sqrt{N_{io}}/\sigma_o & 0 \\ -\rho\sqrt{N_{io}}/\sigma_o & & \sqrt{N_{ic}}/\sigma_c \end{bmatrix}$$

Thus one can obtain GLS estimates from an OLS regression using the transformed variables X* = RX and y* = Ry. For example,

$$y_{io}^* = \sqrt{1-\rho^2}\ (\sqrt{N_{io}}/\sigma_o)y_{io}$$

and

$$y_{ic}^* = (\sqrt{N_{ic}}/\sigma_c)y_{ic} - \rho(\sqrt{N_{io}}/\sigma_o)y_{io} ,$$

where the subscripts o and c denote off-the-air and cable observations, respectively. The independent variables (including the vector of ones for the constant term) are transformed in exactly the same way.

Since σ_o, σ_c, and ρ are unknown, I substitute consistent estimates based on residuals from a regression transformed for sample size alone, reestimate after transforming for within-county correlation as well, and iterate to convergence.

There is also a fourth way in which the errors depart from classical least squares assumptions. Errors for the five different time periods are probably correlated within counties. To handle this, the five different equations should be estimated together as "seemingly unrelated" regressions.[1] This should increase the efficiency of the estimates slightly.[2] I do not pursue this additional complication here because the potential gains do not justify the additional costs, but instead estimate separately equations for each time period.

TOTAL AUDIENCE ESTIMATES

Table 4 shows the estimated equations for the full day and for prime time.[3] Columns (1) through (3) are OLS estimates; columns (4) and (5) are GLS estimates based on the error structure described above. The purpose of the OLS estimates is twofold. First, a comparison of columns (3) and (4) shows what difference the fancy GLS estimation procedure makes. The coefficient estimates are not much changed from their OLS values, but t-statistics are generally higher, presumably reflecting the greater efficiency of the GLS procedure. Second, a comparison of columns (1) and (2) (separate OLS estimates for off-the-air and cable observations, respectively) with columns (3) (made by pooling all observations) justifies using the pooled equation. The F statistics for the additional variance explained by the separate equations are only 1.45 for the full-day period and .78 for prime time. Both fall well short of significance at the .05 level; $F_{4,235,.05}$ is 2.4.

Column (4) shows GLS estimates for each time period based on all 121 counties. An examination using a normal plot of the residuals from the

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[1] See, for example, Kmenta (1971, pp. 517-529).

[2] There would be no efficiency gain at all if the independent variables had the same values in each of the five time periods. They do in fact have the same values except for the GLS transformation, which uses different estimates of ρ, σ_o, and σ_c for the five different periods. Because the transformed variables differ among periods, there should be some efficiency gains from seemingly unrelated regression, but I would not expect it to be large.

[3] The equations for the other three time periods are in Appendix Table B.1.

Table 4

TOTAL AUDIENCE EQUATIONS

Variable	Full Day					Prime Time				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
CONSTANT	.321	.332	.296	.332	.331	.566	.574	.535	.622	.622
	(11.0)	(10.1)	(13.0)	(17.8)	(18.6)	(11.0)	(8.8)	(12.5)	(18.9)	(19.2)
CABLEDUM			.032	.040	.026			.037	.050	.032
			(2.7)	(5.1)	(3.3)			(1.6)	(3.6)	(2.3)
PEN*	-.007	.075	.019	.039	.013	.002	.150	.031	.050	.018
	(.4)	(1.5)	(1.0)	(3.1)	(1.0)	(.0)	(1.5)	(.9)	(2.3)	(.8)
NSTA	.001	-.004	-.002	-.002	-.001	.002	.001	-.001	-.002	-.001
	(.3)	(1.5)	(1.2)	(1.5)	(.8)	(.7)	(.2)	(.4)	(.8)	(.3)
NNET<3	-.005		-.007	-.006	-.001	-.028		-.030	-.022	-.016
	(.6)		(.8)	(.8)	(.1)	(1.9)		(1.7)	(1.6)	(1.2)
TZONE	-.009	-.013	-.009	-.006	-.016	.015	-.005	.008	.004	-.010
	(1.0)	(1.1)	(1.3)	(1.0)	(2.6)	(1.0)	(.2)	(.6)	(.3)	(.9)
INCOME	-.003	.000	-.000	-.007	-.004	.002	.004	.005	-.006	-.002
	(1.2)	(.1)	(.2)	(4.0)	(2.5)	(.4)	(.6)	(1.2)	(2.0)	(.8)
$\hat{\rho}$				.213	.137				.224	.184
R_1^2				.919	.931				.952	.955
R_2^2	.027	.045	.064	.007	.039	.056	.032	.063	.017	.031
N	121	121	242	242	240	121	121	242	242	240
Points of means					.287					.596
					+.026 CABLEDUM					+.032 CABLEDUM

NOTES: The dependent variable is HUT, the fraction of all TV households that are watching TV on average during a particular time period. Student's t-statistics are shown in parentheses. See text for an explanation of $\hat{\rho}$, R_1^2, and R_2^2. Numbered columns show different estimates as follows:

1. Ordinary least squares--off-the-air observations only.
2. Ordinary least squares--cable observations only.
3. Ordinary least squares--both off-the-air and cable observations.
4. Generalized least squares.
5. Generalized least squares after dropping San Francisco.

column (4) full-day equation showed county 5, San Francisco, to be an outlier. The column (5) estimates are based on the 120 counties excluding San Francisco. The exclusion of San Francisco has a noticeable effect on some coefficients and significance levels, but does not affect the overall interpretation of the results.

In addition to estimated coefficients and t-statistics, Table 4 shows $\hat{\rho}$, the estimated within-county correlation of off-the-air and cable error terms, and two R^2 values. R_1^2 is for the equation as actually estimated using transformed variables, that is, the regression of y* on X*. R_2^2 shows how well (or poorly) the estimated equation does in explaining variance in untransformed HUT.[1]

On the surface, the estimates seem to support the view that cable leads subscribers to watch more TV by providing better reception, as against the other two possibilities discussed above. The coefficient of CABLEDUM is the only one that conforms to expectations, being consistently positive and significant. There is no indication in these data that more signals lead to more viewing: The coefficient of NSTA is small, negative (wrong sign), and insignificant; the coefficient of NNET<3 has the right sign but is also consistently insignificant. Also, there is no apparent support for the self-selection hypothesis, which leads one to expect a negative coefficient for PEN* in addition to the positive coefficient of CABLEDUM. In fact, the estimated coefficient of PEN* is positive, and even significantly so when San Francisco is included.

I am, however, reluctant to discard the self-selection hypothesis. Although these results do not provide any support for the hypothesis, they do not provide very strong evidence against it, either. The failure of PEN* to have the expected negative sign may arise because of omitted variables bias. Say there is some unmeasured variable--call it "television appreciation"--that varies from county to county and that is positively correlated with both HUT and PEN*. Then the failure to

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[1] R_2^2 is calculated as (VAR-SSE)/VAR, where VAR = $\Sigma(HUT-\overline{HUT})^2$ and SSE = $\Sigma(HUT-\widehat{HUT})^2$. $\overline{HUT}$ is the mean value of HUT, and $\widehat{HUT}$ represents values predicted using untransformed variables and the GLS estimate of the coefficient vector, $X\hat{\beta}$.

include a television appreciation variable would bias the estimated coefficient of PEN* in a positive direction. My own guess is that this positive bias is in fact present and sufficient to obscure the negative relationship due to self-selection.

So I have not succeeded in settling the question of whether or not cable should get the credit for higher viewing in cable homes. In applying results from this section in Section III, I use both extreme assumptions to calculate likely ranges of the influence of cable on local stations' audiences. At one extreme, cable gets none of the credit for higher viewing; at the other extreme, cable gets all the credit. The question of which assumption is correct (or where, in between, the truth lies), although interesting, turns out not to be too important. We shall see in Section III that the range of values calculated by using the extreme assumption is quite narrow, usually only two or three percentage points wide.

AUDIENCE SHARE MODEL

In my early work on cable impact (1970), I postulated an "attractiveness index" model of audience shares. At that time, data sufficient to estimate the attractiveness indices did not exist, so I filled them in using an eclectic mixture of assumption and estimation. Here I use the same sort of model together with the new data which do make it possible to estimate the attractiveness indices.

I hypothesize that each station can be assigned an attractiveness index a_i such that the audience tends to divide among available signals in proportion to $a_i/\Sigma a_i$, where the summation is over all of the available signals. I assume that attractiveness indices are (largely) determined by the type of station and estimate indices for the following eight station types:

NVL: local network VHF
NUL: local network UHF
IVL: local independent VHF
IUL: local independent UHF
NVD: distant network VHF
NUD: distant network UHF

IVD: distant independent VHF

IUD: distant independent UHF[1]

I allow the attractiveness indices to differ off the air and on the cable. In particular, I expect them to be higher on the cable for local UHF stations and for all distant stations, because of improved reception on the cable. Thus the model is

$$SHR_{io} = \Sigma a_{jo} D_{ij} / \Sigma a_{jo} M_{jo} + u_{io}$$

and (2)

$$SHR_{ic} = \Sigma a_{jc} D_{ij} / \Sigma a_{jc} M_{jc} + u_{ic},$$

where the summations are over the eight station types, D_{ij} is a dummy variable equal to 1 if the i^{th} station is of type j and 0 otherwise, and M_{jo} and M_{jc} are the numbers of available signals of type j off the air and on the cable, respectively.

This specification embodies two constraints that could, and perhaps should, be relaxed in a more complex model. First, the relative effect of the first, second, ..., n^{th} distant station is largely determined by the assumed ratio form of the model. For example, the local station share of cable audience in a market with three network VHF stations, as distant signals increase from 0 to 6 independent stations,[2] is:

Number of Distant Independent Stations	Local Station Share on Cable	Change in Local Station Share
0	1.000	--
1	.904	.096
2	.824	.080
3	.758	.066
4	.701	.057
5	.652	.049
6	.610	.042

[1] In initial regressions, I also included four types of noncommercial stations (local and distant, VHF and UHF), but these consistently failed to achieve indices that were significantly different from zero in either a statistical or a practical sense.

[2] Calculated using estimated attractiveness indices reported below in Table 6.

The sixth station has nearly half the effect of the first, and there is some evidence that the effect of additional independent stations falls off much more rapidly than that.[1] If so, my model will tend to overstate the effect of large numbers of distant stations.

Second, I do not distinguish between primary and duplicate network stations on the cable. My estimated attractiveness index for a distant network station on the cable averages the experience of:

1. Distant network stations carried into markets with three local network stations. These distant stations are blacked out much of the time to provide nonduplication protection to local stations, and hence do not attract very much audience.
2. Distant network stations carried into markets with only one or two local networks. The distant stations that carry the missing network programs will attract substantial audience shares.

The actual attractiveness index will be smaller than my average estimate in the former situation, and greater in the latter.

In earlier work[2] and in the first draft of this report, I transformed equation (2) into a linear form to make it easier to estimate. The transformation results in terms like D_{ij}-$SHR_i M_j$ as variables on the right-hand side of the equation. Unfortunately, the presence of the endogenous component SHR_i in the right-hand side variables results in biased estimates of the attractiveness indices.[3]

I estimate equation (2) using 724 observations on off-the-air or cable audience shares for all of the local stations in 121 counties, together with numbers of each station type available off the air or on cable. "Local" stations are those assigned to the ADI[4] market of which

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[1] FCC, "Methodology," undated.

[2] Park (1970, p. 32) and Park et al. (1976, pp. 244-247).

[3] I am grateful to my Rand colleague Will Manning for emphasizing this point and encouraging me to estimate equation (2) directly using a nonlinear regression program.

[4] Area of dominant influence.

the county is a part; "distant" stations are stations from other markets.[1]

Error Structure

The error structure for my GLS estimates is the same as that for the total audience equations in the previous section. (1) I expect the variance of u in equation (2) to be roughly inversely proportional to sample size N_i. (2) After correcting for sample size, the variance of u is probably greater for off-the-air observations than for cable observations, because of greater variations in reception quality. (3) Off-the-air and cable errors are probably correlated. An unusually popular station off the air is apt to be unusually popular on the cable as well. These three observations imply that the transformation matrix R is the same as that in the previous section.

The transformed dependent variables look just the same as before, that is,

$$y^*_{io} = \sqrt{1-\rho^2}\ (\sqrt{N_{io}}/\sigma_o)y_{io}$$

and

$$y^*_{ic} = (\sqrt{N_{ic}}/\sigma_c)y_{ic} - \rho(\sqrt{N_{io}}/\sigma_o)y_{io}\ .$$

The transformation of the right-hand side is somewhat different, however. Because of the nonlinear specification, the transformation does not apply to the individual independent variables (D_{ij}, M_{jo}, M_{jc}) but rather to the right-hand side as a unit. If we define

$$x_{io} \equiv \Sigma\, a_{jo}D_{ij} / \Sigma\, a_{jo}M_{jo}$$

and

[1] In initial work, I used observations on distant as well as local station shares, 1417 in all, in a pooled regression. The results were plausible, but an F test indicated, at well beyond the .01 level, that separate equations for local and distant stations were required. There is another reason for excluding observations on (at least) one station per county: Because shares for all stations must total one, one observation per county is redundant, and error terms are not independent if all are included.

$$x_{ic} \equiv \Sigma\, a_{jc} D_{ij} / \Sigma\, a_{jc} M_{jc} ,$$

then the transformed right-hand side is

$$x^*_{io} = \sqrt{1-\rho^2}\ (\sqrt{N_{io}}/\sigma_o) x_{io}$$

and

$$x^*_{ic} = (\sqrt{N_{ic}}/\sigma_c) x_{ic} - \rho(\sqrt{N_{io}}/\sigma_o) x_{io} .$$

Ordinary nonlinear regression of y* on x* will minimize $u'V^{-1}u$ to yield generalized nonlinear least squares estimates of the attractiveness indices.

I replace the unknown ρ, σ_o, and σ_c in the transformation matrix with consistent estimates based on the residuals from first-stage regressions reported in Appendix Table B.2. The first-stage regressions were run for off-the-air and cable observations separately, weighted for sample size only. Root mean squared error from each equation was used to estimate σ_o and σ_c; the correlation of residuals from the off-the-air equation with residuals from the cable equation was used as an estimate of ρ. In this case, unlike the total audience model, I stop after the second-stage regressions reported in Table 5 below. This is because nonlinear estimation is relatively expensive and iterating would change the estimates very little. (For example, estimated ρ changes only in the third decimal place from the first- to the second-stage estimates.)

As in the case of the total audience equations, I do not pursue a further complication--the probable correlation of errors between equations for different time periods--but simply estimate a separate equation for each.

ESTIMATED ATTRACTIVENESS INDICES

Table 5 shows the estimated share equations for the full day and for prime time.[1] Also shown are asymptotic t-statistics (in parentheses), the estimated correlation of off-the-air and cable error terms

[1] Estimates for other time periods are in Appendix Table B.2.

Table 5

AUDIENCE SHARE EQUATIONS

	Full Day				Prime Time			
	Network		Independent		Network		Independent	
	VHF	UHF	VHF	UHF	VHF	UHF	VHF	UHF
Off-the-air viewing								
Local stations	1.00	.44	.63	.24	1.00	.55	.56	.14
	(a)	(10.4)	(4.1)	(3.8)	(a)	(12.7)	(4.2)	(2.5)
Distant stations	.10	.00	-.25	.05	.12	.03	-.31	.16
	(5.4)	(.0)	(2.7)	(.1)	(6.2)	(.3)	(3.6)	(.5)
Cable viewing								
Local stations	1.00	.62	.61	.25	1.00	.85	.43	.07
	(a)	(10.7)	(3.2)	(2.8)	(a)	(13.0)	(2.6)	(1.0)
Distant stations	.28	.24	.32	.31	.30	.47	.23	.16
	(12.0)	(2.1)	(4.4)	(3.8)	(12.4)	(3.3)	(3.3)	(2.0)
$\hat{\rho}$	.617				.496			
R_1^2	.622				.649			
R_2^2	.400				.402			

NOTES: The dependent variable is the station share of total audience during each time period. Estimated coefficients are "attractiveness indices" in equation (2). Asymptotic t-statistics are in parentheses. See the text for a description of the nonlinear generalized least squares estimation method used, and a description of $\hat{\rho}$, R_1^2, and R_2^2.

[a]This coefficient is normalized to one as a reference value--not estimated.

for the same station ($\hat{\rho}$), and two R^2 values. As before, R_1^2 is the value for the transformed equation actually estimated, and R_2^2 measures how well the estimated attractiveness indices do in explaining the variance of untransformed SHR (using equation (2)).

The estimated coefficients are for the most part in accord with prior expectations. Local stations handicapped by lack of network affiliation or by UHF transmission have lower indices than do network VHF stations; independent UHF stations, which suffer from both handicaps and which, in addition, often broadcast weaker programs than do VHF independents, have the lowest indices of all local stations. Local network UHF stations have higher indices on the cable than they do off the air, undoubtedly because reception is improved by cable. A similar effect is not apparent for local independent UHF stations, but this is probably because their attractiveness indices on the cable are not estimated very precisely.

The indices for distant stations off the air do not convey much information, because they are highly reception-dependent. They depend mostly on how close out-of-market stations happen to be to our sample counties. The estimated negative index for distant VHF independents received off the air is an anomaly, but not a very important one. I do not use this value in the application of the model in the next section, and when I reestimated the equation with this index constrained to equal zero, the other coefficients changed almost not at all.

Distant stations on the cable generally have much smaller indices than do comparable local stations. The index for distant VHF network stations is quite precisely estimated to be about 30 percent of that of local VHF network stations. The reason, probably, is that the distant stations are "blacked out" on the cable much of the time, pursuant to nonduplication requirements in the FCC regulations. The index for distant VHF independents is (less precisely) estimated to be a little over one-half that of local VHF independents. Indices for distant UHF stations on the cable are roughly the same as those for comparable VHF stations, but standard errors are generally larger.

Constrained Estimates

Cable should improve reception, and hence attractiveness, of all local UHF stations. This effect shows up strongly for network stations, but is obscured by imprecise estimates for independents on the cable. I can increase the precision by "pooling" the experience of network and independent UHF stations in the following sense: I assume that cable increases the attractiveness of local UHF stations (both network and independent) by the same multiple, k. That is, if the off-the-air indices are a_{NUL} and a_{IUL}, the cable indices are ka_{NUL} and ka_{IUL} where k is to be estimated.

The constrained estimates are shown in Table 6. It appears that cable does increase the attractiveness index of local UHF stations. The multiplier k is estimated to be 1.37 in the full-day equation and 1.50 in the prime-time equation. Both estimates are significantly greater than 1 at well beyond the .01 significance level.

F tests of the constrained equations against the unconstrained equations in Table 5 establish that it is legitimate to impose the constraint. The F statistics for additional variance explained by the unconstrained equations are .97 for full day and 2.58 for prime time, well short of the critical value $F_{1,710,.05} = 3.85$.

HOW THE MODELS ARE APPLIED TO GENERATE AUDIENCE DIVERSION PROJECTIONS

The main reason for estimating the models described in this section is so I can use them to make the projections of audience diversion in several different circumstances described in Section III. The following is a description of how the models are used to make the projections, working through a single example in some detail.

Consider a network VHF station in a market that also has three VHF and two UHF independent stations. What is the effect, on the audience of the station under consideration, of cable carrying two distant independent stations? To answer the question, I need to calculate the audience for this station in three different circumstances:

1. There is cable television in the market.

Table 6

CONSTRAINED AUDIENCE SHARE EQUATIONS

	Full Day				Prime Time			
	Network		Independent		Network		Independent	
	VHF	UHF	VHF	UHF	VHF	UHF	VHF	UHF
Off-the-air viewing								
Local stations	1.00	.45	.63	.22	1.00	.56	.57	.09
	(a)	(10.6)	(4.1)	(3.7)	(a)	(12.8)	(4.2)	(2.0)
Distant stations	.10	-.00	-.25	.05	.12	.03	-.32	.16
	(5.4)	(.0)	(2.5)	(.2)	(6.2)	(.3)	(3.6)	(.5)
Cable viewing								
Local stations	1.00	.61	.62	.30	1.00	.84	.44	.14
	(a)	(b)	(3.2)	(b)	(a)	(b)	(2.6)	(b)
Distant stations	.28	.23	.32	.31	.30	.46	.23	.15
	(12.0)	(2.1)	(4.4)	(3.8)	(12.4)	(3.3)	(3.3)	(2.0)
$\hat{\rho}$	.617				.495			
R_1^2	.622				.647			
R_2^2	.399				.401			

NOTES: The dependent variable is the station share of total audience during each time period. Estimated coefficients are "attractiveness indices" in equation (2). Asymptotic t-statistics are in parentheses. See the text for a description of the nonlinear generalized least squares estimation method used, and a description of $\hat{\rho}$, R_1^2, and R_2^2.

[a] This coefficient is normalized to one as a reference value--not estimated.

[b] This coefficient is constrained to equal k times the corresponding off-the-air coefficient; k is estimated to be full day 1.37 (11.7) and prime time 1.50 (12.4).

2. There is no cable television in the market and the self-selection hypothesis[1] is true.

3. There is no cable television in the market and the self-selection hypothesis is false.

For all three calculations, I divide the television households in the market into two parts. If there are T households altogether, I deal separately with the .26T that subscribe to cable if it is offered, and the .74T that do not.[2] All of the calculations make use of the full-day total audience equation in column (5), Table 4, and the full-day audience share equation in Table 6.[3]

1. There is cable. The fraction of non-cable households using television is .287 (Table 4), and the fraction for cable households is .313 = (.287 + .026). Therefore, total audience in non-cable households is .287 x .74T, and total audience in cable households is .313 x .26T. The network VHF station's share of this audience is calculated using the attractiveness indices estimated in Table 6. Its share in non-cable households is 1/(3 + 3 x .63 + 2 x .22) = .188; its share in cable homes is 1/(3 + 3 x .62 + 2 x .30 + 2 x .32) = .164. Thus its total audience is .188 x .287 x .74T + .164 x .313 x .26T = .0533T.

2. There is no cable and the self-selection hypothesis is true. Of those households that would not subscribe to cable if it were offered, the fraction using television is .287. The corresponding fraction of households that would subscribe if they could is .313; these are more avid viewers, even in the absence of cable. The station attracts a .188 share of both portions of the audience, for a total of .188 x .287 x .74T + .188 x .313 x .26T = .0552T.

3. There is no cable and the self-selection hypothesis is false. Of those households that would not subscribe to cable if it were available, the fraction .287 is using television. The fraction for households that would subscribe is the same. They would watch more if they did

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[1] See the discussion of the total audience model above.

[2] The 26 percent cable penetration estimate comes from the cable penetration equation in Park (1971).

[3] The corresponding prime-time equations are used in some of the comparisons to other studies in Section III.

subscribe, but without cable they are indistinguishable from the others. The station gets a .188 share of both portions. Its total audience is .188 x .287 x .74T + .188 x .287 x .26T = .5400T.

These three audience calculations are the basis for the audience diversion projection. The network VHF station's audience with cable (.0533T) is 97 percent of its audience without cable if the self-selection hypothesis is true (.0552T), and 99 percent of its audience without cable if the self-selection hypothesis is false (.5400T).

III. DETAILED RESULTS AND COMPARISON TO OTHER STUDIES

In this section, I use the equations estimated in Section II to project audience diversion for some representative markets. I also compare my results to those of other studies.

AUDIENCE DIVERSION IN SOME REPRESENTATIVE MARKETS

Tables 7 and 8 show the projected effect of cable on local station audience in ten hypothetical markets, clustered to represent top-50, second-50, and below-100 market conditions. For each hypothetical market, I show the effect of three different distant signal packages:

- Those allowed by existing rules. This varies depending on market rank and the number of stations in the market. Neglecting specialty and noncommercial stations, the maximum numbers are three independents in top-50 markets with no independents of their own, and two networks in markets with only one local network station. The actual numbers for each hypothetical market are the first of the three distant signal lineups shown in the tables.
- A larger number of stations that might be carried if the present rules regarding independent signal carriage were relaxed. In actuality, this number will depend on the system operators' perceptions of how many new subscribers an additional distant station would attract, compared with the cost of importing the additional station. I simply assume that the number is six in top-50 markets,[1] five in the second-50 markets, and four in below-100 markets.
- All of the above plus additional stations that might be carried if rules regarding carriage of network signals were also relaxed. My assumption here is that a full

[1] This corresponds to the assumption in Schink and Thanawala (1978).

Table 7

NEAR-TERM EFFECT OF CABLE ON LOCAL STATION AUDIENCE IN REPRESENTATIVE MARKETS UNDER PRESENT AND POTENTIAL RELAXED CABLE REGULATION

Local Stations				Distant Stations		Cable Penetration[a]	Index of Local Station Audience[b] If Cable Exists				
Network		Independent					Network		Independent		
VHF	UHF	VHF	UHF	Net.	Ind.		VHF	UHF	VHF	UHF	Total
Top-50 Markets											
3	0	3	2	0	2	11	99-100		98-99	102-103	99-100
				0	6	11	97-98		97-98	100-101	97-98
				3	6	11	96-97		96-97	99-100	96-97
3	0	1	1	0	2	16	97-99		97-99	103-104	98-99
				0	6	16	94-96		94-95	98-100	94-96
				3	6	16	93-94		93-94	96-98	93-94
3	0	0	2	0	2	9	98-99			101-102	98-99
				0	6	9	96-97			98-99	96-97
				3	6	9	95-96			97-98	96-97
3	0	0	0	0	3	21	95-96				95-96
				0	6	21	91-93				91-93
				3	6	21	89-91				89-91
Second-50 Markets											
3	0	0	0	0	2	17	97-98				97-98
				0	5	17	94-95				94-95
				3	5	17	92-93				92-93
2	1	0	0	0	2	19	95-97	100-102			96-98
				0	5	19	92-93	96-97			92-94
				3	5	19	90-91	93-95			90-92
2	0	0	0	1	2	24	92-94				92-94
				1	5	24	88-90				88-90
				4	5	24	85-87				85-87
Below-100 Markets											
3	0	0	0	0	1	29	97-100				97-100
				0	4	29	91-93				91-93
				3	4	29	87-90				87-90
1	1	0	0	1	1	32	88-91	96-99			91-93
				1	4	32	82-84	87-90			83-86
				4	4	32	78-81	83-85			80-82
1	0	0	0	2	1	41	80-83				80-83
				2	4	41	72-75				72-75
				5	4	41	69-71				69-71

[a]Average present penetration in markets of each type. Data supplied by FCC Cable Bureau.

[b]Average audience over the full broadcast day. The base (100 percent) is the audience if cable does not exist; it assumes that all the audience watches local stations in the absence of cable (that is, there are no overlapping signals from adjacent markets).

Table 8

LONG-TERM EFFECT OF CABLE ON LOCAL STATION AUDIENCE IN REPRESENTATIVE MARKETS UNDER PRESENT AND POTENTIAL RELAXED CABLE REGULATION

Local Stations				Distant Stations		Cable Penetration[a]	Index of Local Station Audience[b] If Cable Exists				
Network		Independent					Network		Independent		
VHF	UHF	VHF	UHF	Net.	Ind.		VHF	UHF	VHF	UHF	Total
Top-50 Markets											
3	0	3	2	0	2	26	97-99		96-98	105-108	97-99
				0	6	28	92-94		91-94	100-102	92-95
				3	6	37	86-89		86-89	96-99	87-90
3	0	1	1	0	2	27	96-98		95-98	104-107	96-98
				0	6	30	89-92		89-91	97-99	90-92
				3	6	38	83-86		83-86	91-95	83-86
3	0	0	2	0	2	28	94-97			103-106	96-98
				0	6	30	88-90			95-98	89-91
				3	6	39	81-84			89-92	82-85
3	0	0	0	0	3	30	92-95				92-95
				0	6	33	86-89				86-89
				3	6	43	78-81				78-81
Second-50 Markets											
3	0	0	0	0	2	29	95-97				95-97
				0	5	32	88-91				88-91
				3	5	41	81-84				81-84
2	1	0	0	0	2	33	91-94	101-104			93-96
				0	5	36	84-87	92-95			86-88
				3	5	46	75-78	84-87			77-80
2	0	0	0	1	2	48	84-88				84-88
				1	5	52	74-77				74-77
				4	5	62	63-67				63-67
Below-100 Markets											
3	0	0	0	0	1	27	97-100				97-100
				0	4	31	90-93				90-93
				3	4	40	83-86				83-86
1	1	0	0	1	1	53	81-85	94-98			85-89
				1	4	58	67-71	77-81			70-74
				4	4	67	56-59	65-69			59-62
1	0	0	0	2	1	74	65-69				65-69
				2	4	77	49-53				49-53
				5	4	84	38-41				38-41

[a]Eventual equilibrium penetration when the whole market is wired, calculated using equation (*) in Park (1971, p. 27).

[b]Average audience over the full broadcast day. The base (100 percent) is the audience if cable does not exist; it assumes that all the audience watches local stations in the absence of cable (that is, there are no overlapping signals from adjacent markets).

complement of three distant networks would be carried in all markets in addition to those allowed by current rules.

Near-term projections for each of the resulting 30 cases are shown in Table 7, and Table 8 shows long-term projections. The near-term projections are based on present cable penetration levels in markets of each type. The long-term projections are based on (usually much higher) ultimate equilibrium penetration levels estimated in Park (1971).[1] These are in all likelihood conservative estimates of cable penetration for the market as a whole; that is, they probably overstate the penetration actually to be expected, and hence overstate the potential audience diversion due to cable. The reason is that the equation is a system penetracion equation, not a market penetration equation. It explains the fraction of homes passed by cable that subscribe, not the fraction of all homes in the market. Hence, to the extent that some portions of the market remain unwired, I would expect average penetration in the market as a whole to fall short of the values shown.

The projections show the audience if there is cable in the market, as a percentage of the audience if there is no cable. In all cases, I show a range of values. The lower end of the range is calculated assuming that cable does not lead to increased TV viewing--households that subscribe to cable if it exists would watch as much TV if cable did not exist. The upper end of the range assumes that cable does result in increased viewing, which partially offsets the diversion of audience to distant signals.

There is a summary discussion in Section I (pp. 7-8) of the results of Tables 7 and 8.

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[1] I assume price of cable service equals $90 per year, median family income equals $16,000 per year, and UHF set penetration equals 100 percent, all approximating current values. Color set penetration is set equal to .5, approximately the mean value in the sample used to estimate the equation, since the coefficient on the color set variable was completely insignificant in the estimated equation. For each market situation, I calculate penetration at the center of the market and penetration halfway out to the B-contour, and average the two figures to obtain the estimates shown in the table for the market as a whole.

COMPARISON TO OTHER STUDIES

Two Early Estimates of Audience Diversion

Park (1970) and Noll, Peck, and McGowan (1973) made projections of audience diversion due to cable before any substantial data on cable viewing were available. They had to make ingenious use of aggregate audience data to come up with their projections. Their results are summarized in Table 9, together with projections based on the estimates in Section II of this report.

My early estimates were intended to be conservative,[1] and it appears that, for the most part, they were. My present estimates of VHF stations' audience loss due to cable are consistently smaller than my earlier estimates. For UHF stations, the two sets of projections are very close.[2]

The Noll, Peck, and McGowan projections for network VHF stations agree very well with the present projections, particularly for three-network markets. Their estimates for UHF independent stations, however, appear to overstate by a large margin the help that cable gives these stations. Taken as a whole, though, both sets of early projections seem remarkably good, given the nature of the data base.

Study for National Association of Broadcasters

A report by Schink and Thanawala (1978), commissioned by the NAB, is an ambitious and generally very well done econometric study using the new data on cable and non-cable audiences. Like this report, theirs

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[1] "...I use 'conservative' to describe assumptions that tend to increase estimated cable impact. Most of the assumptions used *are* conservative, making it likely that the impact estimates are upper bounds. That is, one can be reasonably confident that impact will not exceed the estimates reported here, at least under the circumstances envisioned." Park (1970, pp. 61-62).

[2] It is perhaps worth noting that some broadcast interests vigorously attacked my early study, claiming that it seriously *understated* the adverse effect of cable on broadcast stations. See, in particular, Association of Maximum Service Telecasters (1971) and Twenty-One Television Stations (1971a and 1971b).

Table 9

COMPARISON TO EARLY ESTIMATES OF AUDIENCE DIVERSION MADE WITHOUT BENEFIT OF CABLE-VIEWING DATA

Local Stations				Distant Stations		Cable	Early Estimates[a]				Present Estimates[b]				
Network		Independent					Network		Independent		Network		Independent		
VHF	UHF	VHF	UHF	Net.	Ind.	Penetration	VHF	UHF	VHF	UHF	VHF	UHF	VHF	UHF	Total
Park (1970)															
3	0	2+[c]	0+		4	50	87		88		93-95		83-85		90-93
3	0	1	0+		4	50	84		84		91-93		81-83		89-92
3	0	0	1+		4	50	82			120	88-90			109-112	88-91
3	0	0	0		4	50	84				88-90				88-90
2	1	0	0		4	50	78	110			84-86	101-104			87-90
1	2	0	0		4	50	72	97			79-81	94-97			87-89
0	3	0	0		4	50		83				86-89			86-89
2	0	0	0	1	4	60	66				77-79				77-79
1	0	0	0	2	4	60	52				63-65				63-65
Noll, Peck, and McGowan (1973)															
3	0	3	1		3	48	100		84	170	97-99		86-88	122-125	93-96
3	0	1	1		3	53	96		76	200	92-95		82-84	118-122	91-94
3	0	1	0		4	59	96		76		89-92		78-80		87-90
3	0	0	2		2	53	92			245	92-95			118-121	93-96
3	0	0	1		3	59	92			245	88-91			115-119	89-92
3	0	0	0		4	68	92				84-87				84-87
2	0	0	0	1	4	78	71				70-73				70-73
1	0	0	0	2	4	85	50				48-51				48-51

[a]Source: Park (1970, Table 6.8, p. 76) and Noll, Peck, and McGowan (1973, Table 6-4, p. 163), respectively.

[a,b]Index of average audience during prime time. The base (100 percent) is the audience if cable does not exist; it assumes that all the audience watches local stations in the absence of cable (that is, there are no overlapping signals from adjacent markets).

[c]Plus sign means "or more." Park's early estimates are averages over actual markets; for example, the first line applies to markets with 3 VHF networks, 2 or more VHF independents, and possibly some UHF independents. The corresponding present estimates assume the smallest indicated number of stations (for example, 3 NVs, 2 IVs, and no IUs).

includes separate econometric analyses of total audience and audience share.[1]

Although they employ much the same strategy as I do, their tactics are different in at least three ways:

1. I focus on data for a carefully selected subsample of 121 counties, chosen to be as "clean" as possible and as nearly as possible representative of conditions toward the center of each market. They use data for 998 counties for which ARB reports both cable and off-the-air audience data. This gives them 7816 observations in their station file for cable viewing and 5636 for off-the-air viewing (both local and distant stations), in contrast with only 443 (local stations) in each of mine.

There is something to be said for both choices. I have already argued in favor of my selected sample approach; Schink and Thanawala's large file must include many observations, near the edge of the market, that are of doubtful relevance to the kind of inference we want to make. On the other hand, their large sample supports relatively precise estimation of a fairly large number of coefficients.

The first tactical choice to some extent constrains the second and third.

2. I choose to estimate relatively simple models, which have (at least) the advantage of being simple to interpret. Schink and Thanawala's larger data base supports estimation of more complex equations. These have the advantage of possibly capturing more aspects of a (certainly very complex) reality. On the other hand, they may increase the danger of "over-fitting" the data--finding more apparently significant relationships and less random variation than are in fact present.

3. I pay much attention to error structure and use generalized least squares estimation in an attempt to get the most efficient estimates. Schink and Thanawala use ordinary least squares. They can perhaps

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[1] In addition, the Schink and Thanawala report includes equations for the proportion of households owning TV sets, and the proportion of TV households subscribing to cable service.

afford to sacrifice some efficiency because of their large sample, and on the surface, at least, their estimates do appear to be relatively precise. Their t-statistics should be treated with caution, however, as they are apt to be biased by neglect of the nonclassical error structure.

I am not sure which choice of tactics is better. Schink and Thanawala's projections and mine probably ought to be regarded as complements rather than as competitors. And, in fact, they are in fairly close agreement, as shown by Table 10. The major exception is the projections for a single station market, where theirs show considerably more diversion than do mine. In larger markets, theirs tend to show more diversion than mine, but the difference is usually not large. I suspect that the difference is mostly due to the inclusion of a large proportion of counties near the fringes of their markets in the Schink and Thanawala data base.

Studies by National Cable Television Association

NCTA's submission (1978) includes two studies that are methodologically very different from this report and Schink and Thanawala. In the first study, NCTA examines 58 markets where ADI cable penetration equals or exceeds 33 percent. For each of the 109 commercial stations (all of them network affiliates) assigned to these markets, NCTA calculates the audience loss (or gain) due to cable on a county-by-county basis. It bases the calculation on the difference in the station's share in cable and non-cable homes, and assumes that viewing would not decrease in the absence of cable (the self-selection hypothesis is true).

In the text of their submission, NCTA reports average effects by type of station and number of local stations. Some of their average results are presented in the top part of Table 11. These are difficult to compare with the results of this report, since they average over a wide range of cable penetration (33 to 70 percent) and over a wide variety of distant signal offerings. It seems fair to say, though, that they generally show less effect on local station audience than my results imply. This is particularly true for the smaller markets. For example, consider a 1-VHF network, 1-UHF network market, with cable at 40 percent

Table 10

COMPARISON TO NATIONAL ASSOCIATION OF BROADCASTERS' ESTIMATES OF AUDIENCE SHARES

(Schink and Thanawala, 1978)

Local Stations				Distant Stations		Cable	Schink and Thanawala's Estimate[a] of Local Stations' Audience Share		Present Estimates of Local[b] Stations' Audience Share[a]	
Network		Independent								
VHF	UHF	VHF	UHF	Net.	Ind.	Penetration	Full Day[c]	Prime Time	Full Day[c]	Prime Time
3	0	3	0		1	48	95	96	97-101	98-100
3	0	3	0		6	50	81	83	85-89	88-90
3	0	1	0		1	48	95	96	96-100	97-99
3	0	1	0		6	50	81	84	82-86	85-88
3	0	0	0		1	48	95	96	95-99	97-99
3	0	0	0		6	52	84	85	79-83	83-86
2	1	0	0		2	30	94	95	94-96	96-97
2	1	0	0		5	32	89	91	87-90	90-92
2	1	0	0		2	59	87	90	88-93	92-95
2	1	0	0		5	61	79	82	76-80	82-85
2	0	0	0	1	1	48	84	85	88-92	90-92
2	0	0	0	1	6	52	70	72	72-75	76-78
1	0	0	0	2	1	48	62	66	77-80	78-80
1	0	0	0	2	6	52	48	54	61-64	65-66

[a] Local stations' share of total audience.

[b] Index of average audience. The base (100 percent) is the audience if cable does not exist; it assumes that all the audience watches local stations in the absence of cable (that is, there are no overlapping signals from adjacent markets).

[c] Schink and Thanawala's full day is the union of daytime, early fringe, prime time, and late fringe. This does not include as much as ARB's full day does, so the projections in these columns are only approximately comparable.

Table 11

COMPARISON TO NATIONAL CABLE TELEVISION ASSOCIATION'S ESTIMATES OF AUDIENCE DIVERSION

Local Network Stations		Distant Stations[a]		Cable	NCTA Estimates[b]		Present Estimates[c]	
VHF	UHF	Net.	Ind.	Penetration	VHF	UHF	VHF	UHF
Averages								
3	0	?	?	≥33	93			
2	0	?	?	≥33	87		Comparison	
1	1	?	?	≥33	94	102	difficult;	
0	2	?	?	≥33		79	see text.	
1	0	?	?	≥33	89			
0	1	?	?	≥33		98		
Selected Markets								
Palm Springs								
0	2	3	4	70		76		54-58
Laredo								
2	0	3	0	56	80		83-87	
Rosewell								
1	0	1	4	51	82		68-71	
Binghamton								
1	2	3	3	46	87	103	75-78	83-86
San Diego								
2	1	3	4	35	96	103	82-85	89-92

[a] Not counting specialty or foreign language stations.

[b] Averages show effect on total audience, wherever located, while selected markets show effect on ADI audience only.

[c] Average audience over the full broadcast day. The base (100 percent) is the audience if cable does not exist; it assumes that all the audience watches local stations in the absence of cable (that is, there are no overlapping signals from adjacent markets).

penetration, carrying three distant network stations and two distant independents. My results imply a network VHF audience of 78 to 81 and a network UHF audience of 85 to 88. Both are considerably smaller than the average values NCTA found. Another example: In a 1 network UHF market, a cable system with only 40 percent penetration and two distant network signals would reduce the local station's audience from 80 to 83, according to my results. The NCTA average is 98.

In their supporting Exhibit A, NCTA shows information on the individual markets and stations that underlie the averages. The individual results are easy to compare to the results of this report. I do so for five markets selected to span the range of market sizes and cable penetration represented in the NCTA results. These comparisons, shown in the bottom part of Table 11, confirm the impression that the NCTA results generally show less effect than mine imply.

The reason for the difference is that out-of-market stations are heavily viewed off the air in most of the markets studied by NCTA, so that a comparison of cable and off-the-air viewing of local stations shows relatively little difference. In contrast, my projections assume that, in the absence of cable, 100 percent of the audience watches local stations. Although this is probably a good approximation in most of the larger markets that now have low cable penetration, it is obviously not true of the small, heavily penetrated markets studied by NCTA.

The other major NCTA study is a special survey in five communities to collect data on television viewing separately for basic cable subscribers, pay cable subscribers, and nonsubscribers. The survey produced the interesting result that pay cable subscribers are even heavier viewers than are basic cable subscribers. I shall ignore the pay cable results here, to concentrate on the comparison of non-cable and basic-cable households.

The data are sufficiently detailed to permit construction of impact estimates that correspond exactly to those used in this report--that is, they make it possible to estimate two values for audience with cable as a percentage of audience if cable were not available, one assuming that cable increases TV viewing, the other assuming that it does not. Table

12 shows the effect of cable in the wired area; the penetration figure used in the calculations is subscribers as a percentage of homes passed by. In the first four communities, the NCTA results and those of this report are quite close. In Wilmington, my results predict substantially higher effect than NCTA actually found.

Study by the Motion Picture Association of America

A study by MPAA compares off-the-air and cable shares for local stations in counties with different levels of cable penetration ranging from 10 to 86 percent. Like this report, MPAA excludes counties in which local stations in aggregate fail to attract some minimum level of audience on a full-day basis; in their case, the cutoff is 75 percent. Thus its data, like mine, should be fairly representative of the central areas of television markets, where the bulk of the population is concentrated. By using both 1976 and 1977 data, MPAA comes up with a total of 1198 observations.

For each county, MPAA calculates the aggregate share for local stations off the air and on the cable and its weighted average, which is the aggregate share for the county as a whole (both cable and non-cable households). It then averages its results over all observations that fall into a particular range of penetration. For example, the average local share (on a full-day basis) for counties with 20 to 24 percent cable penetration is about 91.3 percent off the air and 86.7 percent for the county as a whole. The difference is an estimate of the effect of cable on local audience. In this case, local station audience averages 95 percent of what it would be if there were no cable. This and other selected MPAA results are shown in the top half of Table 13.

For all time periods, MPAA consistently finds that audience diversion is higher in counties with higher cable penetration. This is, of course, a combined effect of the higher penetration itself, the generally lower level of off-the-air service in counties with high penetration, and any variation in distant signal imports that is systematically related to penetration. Because MPAA does not control for the latter two factors, a direct comparison with my results is not possible. The

Table 12

COMPARISON TO NATIONAL CABLE TELEVISION ASSOCIATION'S SPECIAL SURVEYS OF AUDIENCE DIVERSION

Local Stations[a]				Distant Stations[a]		Cable	NCTA Estimates[c]		This Report[c]	
Network		Independent								
VHF	UHF	VHF	UHF	Net.	Ind.	Penetration[b]	Full Day	Prime Time	Full Day	Prime Time
Rock Island										
3	0	0	0		2	44	94-99	97-102	92-96	94-96
New London										
5	1	0	0	3	5	64	83-94	90-99	80-85	83-86
Stockton										
3	0	0	1		2	26	97-98	98-100	96-98	97-98
Mobile										
3	0	0	0	1	2	25	96-97	98-99	94-96	95-96
Wilmington										
3	0	0	3	4	2	53	95-103	97-99	83-87	82-85

[a]Not counting specialty stations.

[b]The source is the text of the NCTA comments (1978). Slightly different values are shown in Exhibit D, an attachment to the comments.

[c]The base (100 percent) is the audience if cable does not exist; it assumes that all the audience watches local stations in the absence of cable (that is, there are no overlapping signals from adjacent markets).

Table 13

COMPARISON TO MOTION PICTURE ASSOCIATION OF AMERICA'S ESTIMATES OF AUDIENCE DIVERSION

Local Stations				Distant Stations		Cable	MPAA Estimates[a]		Present Estimates[a]	
Network		Independent								
VHF	UHF	VHF	UHF	Net.	Ind.	Penetration	Full Day	Prime Time	Full Day	Prime Time
?	?	?	?	?	?	20-24	95	96		
?	?	?	?	?	?	40-44	88	89		
?	?	?	?	?	?	60-64	80	82		
3	0	1	0	3	2	22			93-95	94-95
2	1	0	0	3	2	42			84-87	86-88
2	0	0	0	3	2	62			73-77	74-77

[a]Average audience over the full broadcast day. The base (100 percent) is the audience if cable does not exist; it assumes that all the audience watches local stations in the absence of cable (that is, there are no overlapping signals from adjacent markets).

bottom part of Table 13 shows, however, that our results are at least broadly consistent. By making plausible assumptions about off-the-air service and distant signal carriage at different penetration levels, I am able to reproduce the MPAA diversion figures fairly closely.

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Appendix A

DATA DESCRIPTION

All of the data used in this study, and then some, are reproduced in Park (1979). Unless otherwise stated, the data are from the ARB (American Research Bureau) Arbitron Television 1977 County Coverage, CATV--Controlled Counties. The items included are as follows:

COUNTY

County number is arbitrarily assigned. County name and state are also shown.

MARKET

The number shown for the market is its rank according to ARB area of dominant influence (ADI)[1] television households (TVH). The ranking is for 1977-1978.[2] A list that translates market ranks to market names precedes the data tables. A 1 or 2 following the decimal point is arbitrarily assigned to distinguish between markets that tied in the ARB rankings.

TIME ZONE

The code for the time zone in which the county is located is:

1 Eastern
2 Central
3 Mountain
4 Pacific

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[1]A market's ADI includes (with a few exceptions) all those counties within which a market's stations attract more viewers than any other market.

[2]Television Markets and Rankings Guide, 1977-78, Arbitron Television, New York.

INCOME

Median family income in 1969 for the county is from *County and City Data Book, 1972, A Statistical Abstract Supplement*, U.S. Department of Commerce.

COTVH

COTVH is the number of television households (in hundreds) in the county as estimated by ARB for 1977-1978.[1] Numbers are shown separately for non-cable households (0 for off the air) and for cable households (C). Cable penetration in the county (COPEN) as reported in Table 2, Section II, is calculated from COTVH as C/(0+C).

SYSTVH

The number of households (in hundreds) passed by the cable television system's installed trunk and feeder cable are from FCC records. The numbers come from reports that cable systems are required to make to the FCC annually on Form 325. C indicates the number of subscribing households; 0 is the number of households passed by the cable that do not subscribe. The latter number is calculated by subtracting reported subscribers from reported homes passed. In some cases, due to definitional or reporting problems, the result is a negative number. If so, nonsubscribing households passed is set equal to zero. System penetration (SYSPEN) is calculated using SYSTVH as C/(0+C).

The penetration variable (PEN*) used in the total audience regressions in Section II is calculated as follows: For cable observations, PEN* = SYSPEN. For off-the-air observations, it is SYSPEN weighted by nonsubscribing households passed by cable as a proportion of total non-cable households in the county:

$$PEN^* = SYSPEN\ (SYSTVH-0/COTVH-0)\ .$$

[1] As of January 1, 1978.

INTAB

INTAB households (the units here are single households, not hundreds) are those included in ARB's survey sample, reported separately for off-the-air and cable households.

LCLSHR

Local share is the share of full-day (or total) audience captured by local stations, shown separately for off-the-air and cable viewers. Counties with an off-the-air local share less than 70 are excluded from the analysis in this report.

HUT

Homes using television is (roughly) the fraction of television households that are watching television at any given time. It is reported separately for five different time periods or "day parts," some of which are defined differently in different time zones, as follows:

	Eastern and Pacific	Central and Mountain
TOTAL (or FULL DAY)	6:00 am-2:00 am Monday-Sunday	6:00 am-2:00 am Monday-Sunday
DAYTIME	6:00 am-4:30 pm Monday-Friday	6:00 am-3:30 pm Monday-Friday
EARLY FRINGE	4:30 pm-7:30 pm Monday-Friday	3:30 pm-6:30 pm Monday-Friday
PRIME TIME	7:30 pm-11:00 pm Monday-Sunday	6:30 pm-10:00 pm Monday-Sunday
LATE FRINGE	11:00 pm-2:00 am Monday-Friday	10:00 pm-2:00 am Monday-Friday

The fraction of homes using television is calculated from ARB reports of total hours watched as in the following example. ARB estimates that non-cable households in our County 1 watched a total of 718,800 hours per week during the TOTAL or FULL-DAY period. There are 18,100 such households; if they all had watched TV all the time, they would have watched a total of 2,534,000 hours (18,000 households times 20 possible hours per day times 7 days per week). Thus on average over the FULL-DAY period, .284 is the fraction watching TV at any given time.

STATION

Call sign and channel assignment (from the Television Markets and Rankings Guide, 1977-78) are shown for each station reported to be watched in the county. In a few cases, data for parent and satellite stations are combined. Then the first letter of the call sign is replaced by an asterisk. In such cases SHAREs are combined by adding parent and satellite SHAREs, and NWCs (net weekly circulation) are combined by taking the maximum of parent and satellite NWC.

AFFIL

Affiliation codes are as follows:

1 ABC
2 CBS
3 NBC
4 Independent commercial
5 Noncommercial

The first number in the three-digit sequence is primary affiliation; the second, if nonzero, is secondary affiliation; and the third is tertiary affiliation which comes from the Television Markets and Rankings Guide, 1977-78.

MKT

MKT is the rank of the market to which the station is assigned, according to the list that precedes the data tables. If the station's market is the same as the county's market, the station is counted as a local station; otherwise it is classified as a distant station.

SHARE

Station share is the number of households watching a particular station, expressed as a percentage of households watching any station. SHARE is reported separately for each of five time periods, and separately for off-the-air and cable viewers. Shares may not add to 100 because of rounding or because some stations that are watched are not included in the ARB report (notably foreign stations and stations that individually receive very low viewing in the ARB sample). Four

counties (111, 120, 138, and 150) are excluded from the analysis because reported stations' shares total less than 90 percent during either the TOTAL (FULL-DAY) or PRIME-TIME periods.

NWC

Net weekly circulation is the percentage of households (off the air and cable separately) that watch the station at least once a week.

Appendix B

EQUATIONS ESTIMATED FOR OTHER TIME PERIODS

Section II includes results for the full day and prime time only. This appendix includes estimated equations for other time periods as well.

Table B.1 shows total audience equations, comparable to those in Table 4, Section II, for daytime, early fringe, and late fringe periods.

Table B.2 shows the first-stage audience share equations for all five time periods. The first-stage equations for the full-day and prime-time periods provide estimates of σ_o, σ_c, and ρ that I used in the generalized least squares (GLS) transformation to estimate the final share equations in Tables 5 and 6, Section II. I did not estimate final GLS equations for the other time periods because the non-linear computation involved is quite expensive.

Table B.1

TOTAL AUDIENCE EQUATIONS

	Daytime			Early Fringe			Late Fringe		
Variable	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
CONSTANT	.285	.302	.294	.538	.556	.557	.026	.074	.090
	(9.5)	(11.9)	(11.9)	(14.5)	(18.3)	(18.2)	(1.0)	(3.6)	(4.4)
CABLEDUM	.030	.038	.025	.018	.023	.012	.039	.031	.026
	(1.9)	(3.7)	(2.4)	(.9)	(1.8)	(.9)	(2.8)	(3.4)	(2.8)
PEN*	.021	.051	.028	.029	.052	.031	.010	-.003	-.014
	(.9)	(3.3)	(1.7)	(1.0)	(2.8)	(1.6)	(.5)	(.2)	(1.0)
NSTA	-.005	-.002	-.001	-.000	.001	.002	-.002	-.003	-.004
	(2.1)	(1.1)	(.4)	(.1)	(.4)	(.6)	(.9)	(1.6)	(2.2)
NNET<3	.008	.005	.013	-.005	.002	.007	-.001	-.007	-.006
	(.6)	(.5)	(1.3)	(.3)	(.2)	(.6)	(.1)	(.8)	(.7)
TZONE	-.005	.001	-.010	-.087	-.081	-.090	.042	.047	.043
	(.6)	(.2)	(1.2)	(7.4)	(8.0)	(8.7)	(5.1)	(7.1)	(6.2)
INCOME	-.008	-.015	-.011	-.009	-.015	-.013	.013	.008	.008
	(3.0)	(6.3)	(4.7)	(2.8)	(5.4)	(4.4)	(5.6)	(4.3)	(4.2)
$\hat{\rho}$		.292	.228		.305	.282		.108	.156
R_1^2		.825	.827		.933	.929		.804	.809
R_2^2	.072	.024	.020	.243	.222	.233	.286	.267	.265
N	242	242	240	242	242	240	242	242	240

NOTES: The dependent variable is HUT, the fraction of all TV households that are watching TV on average during a particular time period. Student's t-statistics are shown in parentheses. See text for an explanation of $\hat{\rho}$, R_1^2, and R_2^2. Numbered columns show different estimates as follows:

1. Ordinary least squares--both off-the-air and cable observations.
2. Generalized least squares.
3. Generalized least squares after dropping San Francisco.

Table B.2

FIRST-STAGE AUDIENCE SHARE EQUATIONS

	Full Day				Daytime				Early Fringe				Prime Time				Late Fringe			
	Network		Independent		Network		Independent		Network		Independent		Network		Independent		Network		Independent	
	VHF	UHF	VHF	UHF	VHF	UHF	VHF	UHF	VHF	UHF	VHF	UHF	VHF	UHF	VHF	UHF	VHF	UHF	VHF	UHF
Off-the-air viewing																				
Local stations	1.00 (a)	.40 (9.4)	.55 (3.5)	.22 (3.4)	1.00 (a)	.29 (6.5)	.51 (2.7)	.25 (3.2)	1.00 (a)	.34 (6.5)	.85 (3.4)	.34 (3.5)	1.00 (a)	.52 (12.0)	.52 (3.8)	.14 (2.5)	1.00 (a)	.38 (7.7)	.27 (1.7)	.18 (2.5)
Distant stations	.07 (3.8)	.10 (.9)	-.08 (.6)	.24 (.5)	.05 (2.5)	.07 (.6)	-.04 (.2)	.27 (.5)	.04 (2.0)	.05 (.4)	-.03 (.1)	.23 (.4)	.11 (5.3)	.15 (1.2)	-.14 (1.1)	.14 (.4)	.06 (3.0)	.13 (1.0)	-.07 (.4)	.22 (.4)
$\hat{\sigma}_o$	.932				1.135				1.261				.836				1.100			
Cable viewing																				
Local stations	1.00 (a)	.57 (9.6)	.52 (2.7)	.23 (2.5)	1.00 (a)	.41 (6.2)	.51 (2.0)	.26 (2.2)	1.00 (a)	.39 (5.5)	1.19 (3.3)	.52 (3.3)	1.00 (a)	.83 (12.3)	.38 (2.3)	.07 (.9)	1.00 (a)	.51 (6.1)	.25 (1.0)	.18 (1.4)
Distant stations	.27 (8.7)	.31 (2.2)	.46 (4.4)	.35 (3.2)	.19 (6.9)	.15 (1.1)	.42 (3.2)	.40 (2.8)	.27 (7.5)	.03 (.2)	.92 (4.6)	.85 (4.3)	.30 (11.3)	.57 (3.4)	.31 (3.7)	.17 (1.8)	.25 (6.8)	.17 (1.0)	.36 (2.5)	.32 (2.0)
$\hat{\sigma}_c$	.483				.673				.637				.453				.743			
$\hat{\rho}$	.615				.573				.673				.495				.572			

NOTES: The dependent variable is the station share of total audience during each time period. Estimated coefficients are "attractiveness indices" in equation (2). Asymptotic t-statistics are in parentheses. The equations were estimated using nonlinear least squares.

[a]This coefficient is normalized to one as a reference value--not estimated.